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Chapter 7

Neoliberalising technoscience and environment: EU policy for competitive, sustainable biofuels

Les Levidow, Theo Papaioannou and Kean Birch

Introduction

Since the 1990s the European Union's biofuels policy has espoused several aims: energy security, greenhouse gas (GHG) savings, technology export and rural development. On these various grounds, by 2007 the EU was moving towards statutory targets, i.e. to mandate larger markets for 'renewable energy' including biofuels. However, controversy erupted over harmful environmental and social effects, especially in the global South, where land-use changes were anticipating and supplying a larger EU market for biofuels.

In response to the controversy, policymakers and experts focused blame on 'conventional' biofuels, as if these were a transient yet necessary phase towards sustainable biofuels. When enacted in 2009, statutory targets were accompanied by sustainability criteria. Together these incentives and standards were expected to generate technoscientific innovation towards novel, more competitive and sustainable biofuels by using renewable resources more efficiently. Given these policy assumptions about benign markets fulfilling societal needs via technoscientific innovation, EU biofuel policy can provide a case study for relationships between neoliberalism and technoscience.

This chapter will discuss how EU biofuels policy:

- stimulates new markets for knowledge as well as resources;
- assumes that markets drive beneficent innovation; and thus
- deepens links between markets, technoscience and environment.

The theoretical concept 'neoliberalizing the environment' will be extended to links between technoscience and natural resources.

The chapter is structured as follows: The first section discusses analytical perspectives on neoliberalism and technoscience; second section focuses on EU biofuel policy, examining market drivers and economic imaginaries; third section analyses value chains in biofuels; fourth section looks at expectations for a sustainability technofix; fifth section discusses controversy over EU biofuel targets; and Conclusion summarises the main argument.

Analytical perspectives: Neoliberalism and technoscience

To explore the above issues, the chapter draws on several analytical perspectives linking neoliberalism with technoscience and environment. As elaborated later in this section, such perspectives can be summarised and linked as follows.

Neoliberalism is a complex process that includes ideological, economic and political dimensions, according to Jessop (2002: 435–54). Ideologically, neoliberalism calls for organization of economic, political and social relations through formally free choices of profit-seeking individual actors. Economically, this can happen only through expansion of a liberalized, deregulated market within and across national borders. Politically, neoliberalism implies the roll-back of Keynesian intervention and a commitment to the formal freedom of individual actors in the market.

As a process of institutional change, neoliberalism is driven by an underlying assumption that the 'free market' – conceived as natural, neutral and efficient – *should* be the main means to allocate

resources. Hence free markets must be created in order to obtain their benefits (Harvey 2005). As regards the environment, such putative benefits include greater efficiency in natural resource use, better conservation, better evaluation of environmental risks, etc. (Castree 2008).

In neoliberal policy frameworks, ‘the market’ must be designed (or simply presumed) to optimise resource usage; this is done by stimulating technoscience, regulating its forms or direction, and distributing its societal benefits. Resource problems are attributed to market inefficiency, to be remedied by technological advance, stimulated and constituted by market competition. Beyond simply extracting and processing resources, technological innovation redesigns resources as commodities for appropriation and sale, especially through privatizable knowledge. Such frameworks neoliberalize the environment: in the name of protecting natural resources, they are more readily appropriated and turned into exchange value. Neoliberalism thereby promotes market competition as a driver of technoscientific advance that will enhance resource and thus sustainability (Birch, Levidow and Papaioannou 2010).

Incorporating such neoliberal assumptions, EU policy frameworks promote technoscientific development as a key instrument for international competitiveness. Economic imaginaries represent future markets as benefiting a European economic community, as a basis to mobilize resources and policy support for such markets. This framework also represents ‘Europe’ as a single unit of market competition, while also promoting integration into global capital. Socio-technical imaginaries present eco-efficiency as reconciling economic competitiveness and environmental sustainability. Each aspect is elaborated in the literature survey that follows.

Market-like rule for extending productivity and plunder

As a central tension within neoliberalism, markets are at once redesigned and naturalized, likewise politically constructed and depoliticized. Neoliberal agendas generally involve the ‘mobilization of state power in the contradictory extension and reproduction of market(-like) rule’, argue Tickell and Peck (2003: 166). Through ‘market-friendly’ regulations, neoliberal policies have extended various processes such as privatization, marketization, commodification *etc.*, thereby promoting competitive market relations (Heynen et al. 2007).

Expressing classical economic liberalism, eighteenth-century utilitarians portrayed the market as the natural regulator, complementing the natural liberty of the entrepreneur to trade without interference. Through metaphors of machine and market, this new discourse justified the Enclosures as transforming agricultural land into capital, along with new institutions to police dispossession from common lands. Such ideas undermined the earlier discourse of ‘natural law’, meaning the natural justice of yeomanry living from their own labour on the land as a common societal resource (Williams 1980: 79).

In such ways, classical economic liberalism espoused ‘free markets’ as if the state were removing unnatural interference from naturally given market exchange. In practice, freedom to exploit resources depends on various coercive measures by the state in establishing and enforcing property rights. Such arrangements have been naturalized as a ‘self-regulating market’. Employers’ coercive power takes the form of an apparently free, competitive exchange between buyers and sellers. Yet ‘the market has been the outcome of a conscious and often violent intervention on the part of government which imposed the market organization on society for non-economic ends’ (Polanyi 2001: 258). By treating potentially everything as commodities to be exploited, ‘free-market’ liberalism provoked resistance against its destructive effects.

In neoliberalism, by contrast to its classical precedent, market conditions are more explicitly constructed to optimise their beneficent role. Conditions necessary for the success of the neoliberal project include individual property rights that enable and ensure competition between individuals in ‘free’ markets – i.e., where individual property rights are secured against common or social rights. ‘Contrary to classical liberalism, neoliberals have consistently argued that their political program will only triumph if it becomes reconciled to the fact that the conditions for its success must be *constructed*, and will not come about “naturally” in the absence of concerted effort’ (Lave, Mirowski and Randalls 2010: 661).

Through a circular reasoning, an omniscient market can be adjusted to redress problems that it has caused. As core principles of neoliberalism,

The Market is an artifact, but it is an ideal processor of information. Every successful economy is a knowledge economy. [...] The Market (suitably re-engineered and promoted) can always provide solutions to

problems seemingly caused by The Market in the first place. (Lave, Mirowski and Randalls 2010: 662–3)

With such expectations for the market, neoliberalism more readily justifies the exploitation of human and natural resources.

The entire history of capital accumulation has depended on dispossessions which subordinate labour to capital and colonize natural resources (Marx 2000). In his concept of primitive accumulation, Marx referred to ‘the historical process of divorcing the producer from the means of production’. Entire populations were ‘forcibly torn from their means of subsistence’, thus expropriating the agricultural producers from the soil (Marx 1976: 875–6).

Marx’s concept has been extended to an ongoing process called ‘accumulation by dispossession’, which primarily relates to the privatization of commons or shared resources (Himley 2008: 443). This trans-historical concept draws present-day analogies with early capitalism:

A closer look at Marx’s description of primitive accumulation reveals a wide range of processes. These include the commodification and privatization of land and the forceful expulsion of peasant populations; conversion of various forms of property rights (common, collective, state, etc.) into exclusive private property rights; suppression of rights to the commons; commodification of labor power and the suppression of alternative (indigenous) forms of production and consumption; colonial, neo-colonial and imperial processes of appropriation of assets (including natural resources); monetization of exchange and taxation (particularly of land); slave trade; and usury, the national debt and ultimately the credit system as radical means of primitive accumulation. [...] All the features which Marx mentions have remained powerfully present within capitalism’s historical geography up until now. (Harvey 2003: 145)

More generally, capital accumulation has depended upon ‘the endless commodification of human and extra-human nature’ (Moore 2010: 391). Although several technical improvements helped to make the steam engine economically viable, its success ‘was unthinkable without the vertical frontiers of coal mining and the horizontal frontiers of colonial and white-settler expansion in the long nineteenth century’ (Moore 2010: 393). Cheap or nearly free raw materials have been supplied by cheap labour, which remains the ultimate source of surplus value: in expending their own labour, workers produce greater exchange value than the cost of reproducing their labour power.

Here lies a practical contradiction: capital-intensive technological innovation transforms living labour into dead labour (e.g. machinery or materials) and so increases the organic composition of capital, i.e. the ratio of dead labour to living labour. This may be done to reduce capital’s dependence on labour and to discipline the labour that remains. By reducing the proportion of living labour, however, innovation tendentially limits surplus value. To overcome this limit, geo-spatial expansion has appropriated more human and natural resources: ‘hence the centrality of the commodity frontier in modern world history, enabling the rapid mobilization, at low cost (and maximal coercion), of epoch-making ecological surpluses’ (Moore 2010: 393).

Industrialization is popularly associated with technological innovation, as if this were the crucial driver.

And yet every epoch-making innovation has also marked an audacious revolution in the organization of global space, and not merely in the techniques of production. [...] The revolutionary achievements were made through plunder as much as through productivity. This dialectic of productivity and plunder works so long as there are spaces that new technical regimes can plunder cheap energy, fertile soil, rich mineral veins. (Moore 2010: 405)

Thus global space must be reorganized for realizing the profitability of technological innovation.

From that critical perspective, technoscientific innovation for more efficient resource usage depends upon and facilitates plunder. Conversely, greater resource usage is driven by greater efficiency, e.g., in extracting and processing raw materials. These causal relations operate in both directions: new opportunities for plunder can drive technoscientific innovation for greater productivity.

The tendency towards plunder is disguised, or even reversed, by a hegemonic neoliberal discourse. According to its promises, greater productive efficiency reduces the need for resources and so helps to conserve them. In a circular logic, market competition becomes an environmental saviour by stimulating gains in efficiency and thus sustainability. Environmentalism has been incorporated into models of market progress: this ‘has done far more to smooth the “roll-out” of neoliberalizations than attempts to dismiss or reject environmental concerns outright’ (McCarthy and Prudham 2004: 279).

To address sustainability problems, the extension of markets has been linked with a technological fix, whose development ‘relies on the coercive powers of competition’. This ‘becomes so deeply embedded in entrepreneurial common sense, however, that it becomes a fetish belief that there is a technological fix for each and every problem’ (Harvey 2005: 68). Such expectations frame sustainability problems as a technical inefficiency, to be overcome by technoscientific innovation.

Technoscientific innovations have been celebrated for greater efficiency, which have facilitated plunder, especially in the agricultural sector. Multinational corporations have successively colonized ‘a multitude of new spaces that could not previously be colonized either because the technology or the legal rights were not available’ (Paul and Steinbrecher 2003: 228–9). Since the classical enclosures of the eighteenth century, land access has been obtained by formally withdrawing traditional land rights and/or bypassing them through violence. Such enclosures have been extended by biofuel developments in the global South (Levidow and Paul 2010).

As in earlier historical periods, technoscientific innovation is again promoted as means to alleviate competition for resources and to expand their availability, especially to avoid the conflicts around biofuels. Such conflicts are attributed to inefficiency or mis-management, thus diverting responsibility from market competition and its policy drivers (Franco et al. 2010). By historical analogy, ‘new efficiencies are likely to generate further economic incentives for monocultural systems to supply biomass to centralised biorefineries’ (Smith 2010: 120; cf. Levidow and Paul 2011).

As indicated by the ‘biomass’ concept, natural resources are always constructed in particular ways. These reorient biophysical characteristics by devising new knowledge and technologies in order to increase productivity and thereby the accumulation of capital. For a long time, this has meant transforming nature into resources through commodification after extraction; this can be seen as the ‘formal subsumption of nature’, by analogy to labour exploitation (Boyd, Prudham and Schurman 2001).

Resource use also increasingly involves the ‘intensification of biological productivity (i.e., yield, turnover time, metabolism, photosynthetic efficiency)’ — or the ‘real subsumption of nature’. Nature ‘is (re)made to work harder, faster and better’. Yet intensification efforts cannot assume the predictable compliance of nature, whose biophysical characteristics may prove recalcitrant to more efficient use. So there is no way to ensure predictability or control of nature prior to implementing new technologies (Boyd, Prudham and Schurman 2001: 563–4).

Real subsumption of nature exemplifies a wider process of neoliberalizing nature. As politics by other means, this process takes many forms – privatization, marketization, deregulation, reregulation, etc. ‘For it involves the privatization and marketization of ever more aspects of biophysical reality, with the state and civil society groups facilitating this and/or regulating only its worst consequences’ (Castree 2008: 142–3). Various ecological fixes are devised for the problem of capital accumulation – often in the eco-friendly name of conserving resources, but also in the name of remaking nature.

These logics show that ‘neoliberalism’ is, in environmental terms, an apparent paradox: in giving full reign to capital accumulation it seeks to both protect and degrade the biophysical world, while manufacturing new natures in cases where that world is physically fungible. In short, nature’s neoliberalisation is about conservation and its two antitheses of destroying existing and creating new biophysical resources. (Castree 2008: 150)

A similar contradiction arises in techno-fixes for environmental problems: such innovations reconceptualize and redesign natural resources for more effective commoditization, while also accounting for such resources in its own market-like image.

As a recent controversial example: Biofuels and EU targets have been promoted by new corporate alliances spanning several industrial sectors; they aim to restructure agriculture as a biomass

source for diverse industrial products, especially as opportunities for privatizable knowledge. Extra demands on land provoked public and expert controversy about how the necessary biomass could be produced sustainably (Franco et al. 2010, Levidow and Paul 2010). As a means to legitimize biofuel targets, sustainability has been conceptually reduced to carbon accounting. These concepts lie at the nexus of the Low-Carbon Economy, a policy concept fetishizing carbon cycles as the prime indicator of sustainability, e.g. for biofuels.

Although claims for environmental benefits have been questioned, the biofuel controversy has been ‘constructed as purely physical debates’, especially about carbon accounting.

The challenge of developing biomass energy systems to reduce carbon emissions is by definition a question of industrial ecology. It requires accounting for the flows of energy and matter (in this case especially carbon) throughout every step of the supply chain, from growing plants to harvesting, processing and transporting them to converting them to useful energy to the disposal of remaining ‘wastes’ which are ideally reused as new resources. The holistic approach of lifecycle analysis also lends itself to the framing of biomass within the terms of the dominant energy discourse of carbon cycling. (van der Horst and Evans 2010: 180)

Here resources are framed in the image of an accumulation regime, pursuing new commodity frontiers, thus projecting a particular vision of the future.

EU policy imaginaries for technological-market progress

The above technoscientific visions can be analysed as imaginaries – ‘representations of how things might or could or should be’. These may be enacted as networks of practices (Fairclough 2010: 266). Imaginaries have many aspects and forms, e.g. socio-technical and/or economic (Jasanoff and Kim 2009, Jessop 2005). Innovation agendas combine socio-technical *and* economic imaginaries as complementary visions of societal progress (Levidow, Birch and Papaioannou 2012). These imaginaries enable and reinforce each other: economic conditions for commoditizing knowledge are presupposed by socio-technical progress and vice-versa. Given this circularity, techno-fixes in neoliberal imaginaries are powerful and difficult to contest; they can become self-fulfilling prophecies. Next such imaginaries will be highlighted in EU policy frameworks.

EU innovation policy has been analysed as socio-technical imaginaries of feasible, desirable futures. According to a report criticizing EU policy, *Science and Governance: Taking European Knowledge Society Seriously*, prevalent imaginaries anticipate future technoscientific development as central to societal progress:

Science and technology in this imaginary are staged unambiguously as the solution to a range of social ills, including the problematic identity of Europe itself. To the extent that S&T are recognised to generate problems, these are cast solely in the form of mistaken technological choices. There is no question about whose definition of society’s problems or needs S&T should to address, nor any prior question about who participated in determining what is seen to be a ‘worthwhile’ (commercially profitable or socially needed?) objective or outcome. Accordingly, the immensely normatively-loaded term ‘progress’ is black-boxed and its democratic examination is curtailed. (Felt and Wynne 2007: 80)

As the report argues, an ‘economics of technoscientific promise’ creates beneficent expectations in order to attract resources – financial, human, political, etc. Such expectations conflate technoscientific advance with societal progress.

It is typically simply assumed that the mere advancement to market of a new product, process or technology is sufficient to demonstrate genuine social ‘benefit’ – despite well-established understandings of market failures, price externalities and the motivating power of vested interests. (Felt and Wynne 2007: 88)

In such ways, socio-technical imaginaries convey ‘unifying narratives of imagined and promised European futures, in order to justify interventions and pre-empt disruptive public responses’ (Felt and

Wynne 2007: 75). Such futures are deployed to promote specific policy changes and to marginalize dissent.

Related to socio-technical imaginaries are economic ones, e.g. imagining the EU as an economic community which will share the benefits of future markets and competition. One such imaginary is the 'Knowledge-Based Economy' (KBE), a policy agenda which links current markets with future ones. The KBE has been largely shaped by the neoliberal agenda, prioritizing knowledge that can be privatized. Through the KBE policy framework, the state

is promoting the commodification of knowledge through its formal transformation from a collective resource (intellectual commons) into intellectual property (for example, in the form of patent, copyright and licences) as a basis for generating profits of enterprise and rents for individual economic entities as well as for its own fisco-financial benefit., though there remains scope for counter-hegemonic versions. (Jessop 2005: 159)

Initially focusing on ICT, the KBE agenda has been extended to 'the Knowledge-Based Bio-Economy' (KBBE), emphasizing more efficient ways to use and commoditize renewable raw materials, especially from novel organisms or processes. In the KBBE's dominant imaginary, environmental sustainability is translated into a benign eco-efficient productivity through resources which are renewable, reproducible and therefore sustainable; such resources become 'biomass' for flexible conversion to various industrial products. This imaginary has been elaborated by European Technology Platforms in the agri-food-forestry-biofuels sectors, whose proposals shape research priorities and policy agendas. Together these promote a further privatization and commodification of nature, especially by prioritizing knowledge that can extend intellectual property rights (Birch, Levidow and Papaioannou 2010).

EU economic imaginaries have evolved over time, with tensions between early mercantilist versus later neoliberal forms, whereby the latter have facilitated integration of European capital into global capital as an essential route to competitiveness (van Apeldoorn 2002). Towards this aim, neoliberal policies have extended deregulation, privatization, public-private partnerships, intellectual property rights, etc., thus forcibly creating new market relations. In a European context, the political integration process was conceived as an opportunity to further open up the European region to the globalizing world economy and to accelerate the deregulation and privatization of the European economies, liberating market forces from the fetters of government intervention (van Apeldoorn 2000: 166).

These socio-technical and economic imaginaries are combined in ways shaping societal futures. Neoliberal imperatives – including private property rights, competition, market liberalization, etc., – are promoted as necessary means to facilitate beneficent technoscientific developments. Regardless of whether the latter materialize in commercial form, policy frameworks change institutions, thus shaping societal futures and resource usage along specific lines, while pre-empting alternatives: 'If the model is too simple (as we have argued), the diagnosis and policy measures linked to it will not be productive – but will still shape society' (Felt and Wynne 2007: 19). By drawing on the above concepts, let us examine the case of EU policy framework for promoting and justifying a larger market for biofuels.

EU biofuel policy: Market drivers and techno-economic imaginaries

Since the 1990s EU biofuels policy has featured three main justifications– economic advantage, energy security and greenhouse gas (GHG) savings – for promoting 'sustainable' technologies. The first two issues are discussed here and the third issue in the penultimate section below.

According to many policy documents, biofuels offer more secure energy supplies for Europe, save greenhouse gas (GHG) emissions to address global warming, and promote economic development in the rural places where they are produced (CEC 1997, 2001, EC 2003, Biofrac 2006). The meaning and relative weight of these arguments has changed over time, mainly in response to wider policy agendas and public dissent. From an early concern with energy security, commitments to the Kyoto Protocol became increasingly important, driving efforts to reduce GHG emissions (CEC 1997, 2000).

The renewable energy sector has been expected to promote economic development through the creation of expert knowledge, renewable technologies and thus export opportunities for EU industries as 'world leaders' (CEC 1997: 4). In particular, second-generation biofuels are expected to 'boost innovation and maintain Europe's competitive position in the renewable energy sector' (CEC 2007b).

For strategic advice on creating markets for biofuels, the European Commission established the Biofuels Research Advisory Council (Biofrac), representing industrial interests pursuing biofuel innovation. In its future vision, Biofrac claims that: 'By 2030 the European Union covers as much as one fourth of its road transport fuel needs by clean and CO₂-efficient biofuels.' Such eco-efficiency will come from horizontally integrating agriculture with other industrial sectors: 'Integrated biorefineries co-producing chemicals, biofuels and other forms of energy will be in full operation' (Biofrac 2006: 16). Economic development is framed as newly created markets facilitating new sustainable technologies that will yield financial returns.

An imaginary combining economic and environmental sustainability was elaborated in a policy report, *An EU Strategy for Biofuels*. The EU faces an opportunity for global leadership through technoscientific advance:

In general, the production of biofuels could provide an opportunity to diversify agricultural activity, reduce dependence on fossil fuels (mainly oil) and contribute to economic growth in a sustainable manner. [...] The options, which will be developed, need to be sustainable in economic, environmental and social terms, and bring the European industry to a leading position. (CEC 2006a: 6–7)

Extending that imaginary, EU policy seeks to develop and maintain a competitive advantage for biofuel innovation in global markets. Second-generation biofuels are expected to 'boost innovation and maintain Europe's competitive position in the renewable energy sector' (CEC 2007b: 11). According to the European Commission:

By actively embracing the global trend towards biofuels and by ensuring their sustainable production, the EU can exploit and export its experience and knowledge, while engaging in research to ensure that we remain in the vanguard of technical developments (CEC 2006a: 5).

In parallel, long-term market-based policy mechanisms could help achieve economies of scale and stimulate investment in 'second generation' technologies which could be more cost effective. (CEC 2006b: 28)

Energy insecurity was always another rationale for promoting biofuels. Use of transport fuel is expected to grow, to become more dependent on imports of fossil fuel, and thus to become less secure: 'there is a particular need for greenhouse gas savings in transport because its annual emissions are expected to grow by 77 million tonnes between 2005 and 2020 – three times as much as any other sector'. Consequently, 'the only practical means' to gain energy security is biofuels, along with efficiency measures in transport, argued the European Commission (CEC 2007b: 2, 7). This imperative was reiterated by DG Tren, the *chef de file* for energy policy:

The sector is forecast to grow more rapidly than any other up to 2020 and beyond. And the sector is crucial to the functioning of the whole economy. The importance and the vulnerability of the transport sector require that action is taken rapidly to reduce its malign contribution to sustainability and the insecurity of Europe's energy supply. (DG Tren 2009)

Raw material for biofuels was originally meant to come from 'indigenous' sources, especially so that the EU could reduce its dependence on imports and so enhance its energy security (e.g. CEC 1997: 4, CEC 2000, CEC 2006b). But prospective sources were later broadened to developing countries (e.g. CEC 2008). That shift responded to industry projections that half the EU biofuel supply could come from imports by 2030 (Biofrac 2006: 16).

This imaginary naturalizes the increase in EU-wide transport as an objective force that must be accommodated. In practice, the increased demand for transport fuel has been driven by the internal market project and EU subsidy for transport infrastructure (Bowers 1993, Fairlie 1993). In that context, EU biofuel policy evades its own responsibility for unsustainable growth, especially by displacing the problem onto new technoscientific means to satisfy both market demands and environmental sustainability. However, public controversy eventually led to a political compromise in EU policy, linking high targets with sustainability criteria (see penultimate section).

Horizontally integrating value chains, extending commodity frontiers

A biofuels market provides an opportunity to expand industrial agriculture on a global scale, facilitating technological innovation and extending commodity frontiers. This opportunity overlaps with a new policy agenda relaunching the Life Sciences as essential tools for a Knowledge-Based Bio-Economy (KBBE) (DG Research 2005). Although the KBBE has been defined in various ways, the dominant account presents natural resources as renewable biomass amenable to conversion into industrial products via a diversified biorefinery, thus horizontally integrating value chains and linking ecological efficiency with economic development (Becoteps 2011). That is, environmental sustainability becomes dependent upon markets to stimulate technological innovation. These imaginaries inform EU agendas for R&D funding.

Biorefinery: Diversifying production from agro-industrial oil wells

Funded by the European Commission, an international research network has developed research agendas around the biorefinery concept. Since 2006 it has aimed to design new generations of bio-based products derived from plant raw materials that will reach the market place ten to fifteen years later (EPOBIO 2006). Its bio-economy vision changes the role of agriculture, which becomes analogous to oil wells:

It was noted by DOE [Dept of Energy] and E.U. that both the U.S. and E.U. have a common goal: Agriculture in the 21st century will become the oil wells of the future—providing fuels, chemicals and products for a global community. (BioMat Net 2006)

As a primary means to extract and recompose valuable substances for a biorefinery, ‘Biotechnology has the potential greatly to improve the production efficiency and the composition of crops and make feedstocks that better fit industrial needs’ (EPOBIO 2006: 8).

The ‘diversified biorefinery’ takes biotechnology beyond first-generation GM crops to more novel ones. Since the 1980s genetic modification techniques have targeted four major crops—corn, soybeans, oilseed rape (canola) and cotton; the first three have been grown increasingly for animal feed. Now industry can use these crops to produce fuel, while also using the residue to produce animal feed and other industrial co-products. Even without GM crops as feedstock, biorefineries are being designed to diversify inputs and outputs, especially through novel enzymes and processing methods. According to a promotional account, renewable (and therefore sustainable) resources will generate by-products which become inputs for more energy production:

The integrated diversified biorefinery—an integrated cluster of industries, using a variety of different technologies to produce chemicals, materials, biofuels and power from biomass raw materials agriculture—will be a key element in the future. And although the current renewable feedstocks are typically wood, starch and sugar, in future more complex by-products such as straw and even agricultural residues and households waste could be converted into a wide range of end products, including biofuels. (EuropaBio 2007: 6)

This biorefinery vision poses the dual opportunity and imperative of linking diverse sectors along a value chain providing food, animal feed, energy, novel industrial products, etc. Agricultural raw materials become a universal renewable resource that can be used in more efficient ways, thus contributing to sustainability. According to the predecessor of the Biofuels Technology Platform, in the year 2020:

Integrated biorefineries co-producing chemicals, biofuels and other forms of energy will be in full operation. The biorefineries will be characterised, at manufacturing scale, by an efficient integration of various steps, from handling and processing of biomass, fermentation in bioreactors, chemical processing, and final recovery and purification of the product. (Biofrac 2006: 16)

To reap the benefits, e.g. green energy, society faces an objective imperative of horizontal integration across numerous industrial sectors:

The production of green energy will also face the exceptional challenge of global industrial restructuring in which the very different value

chains of agricultural production and the biorefining industries must be merged with the value chains of the energy providers. (ETP Plants for the Future 2007: 33)

This innovation agenda links major agricultural industries – e.g., seed, fertilizer, pesticide, commodities and biotechnology – with the energy sector, including the oil, power, and automotive industries. This imaginary foresees production systems as sustainable by using renewable resources, unlike fossil fuels. To better achieve this sustainable future, industry seeks a flexible horizontal integration by diversifying biomass sources and its potential uses. Their research priorities are promoted by various technology platforms, as invited and funded by the European Commission. In particular the European Biofuels Technology Platform advocates the following research aims:

- Maximization of yield and crop resistance to biotic and abiotic factors (pests, diseases, water scarcity, rising temperatures, etc.).
- Initiate innovative cropping systems to allow efficient, bulk material production for food, feed, fiber and fuel (4F agricultural systems).
- Exploitation of marginal land options (EBTP 2008: SRA-24).

The latter concept ‘marginal land’ imagines vast land tracts as surplus to food and other needs. In practice, this means land ‘marginal’ to global value chains, regardless of its importance to local populations. Through the concept of ‘marginal land’, investors imagine crop cultivation becoming lucrative via novel processes which can more efficiently extract and convert natural resources. According to an NGO critique, however:

What’s seen as marginal land is often land used by marginalized people, by economically weaker sectors of communities, especially women. Much of it is communal land, collectively used by local people who might not have an individual land title, but for whom it is a vital resource for water, feed, food, medicines, fuel and other purposes. (Econexus 2009: 6)

Thus the concept readily disguises new enclosures of arable land and rural populations.

Beyond simply extracting more resources, these are imagined as cornucopian renewable substances, to be enhanced in quantity and market value by redesigning plants through new technologies. The Biofuels Technology Platform develops strategies to optimize valuable products from novel inputs. It requests funds to ‘[d]evelop new trees and other plant species chosen as energy and/or fiber sources, including plantations connected to biorefineries.’ For advanced biofuels, a biorefinery needs: ‘Ability to process a wide range of sustainable feedstocks while ensuring energy and carbon efficient process and selectivity towards higher added value products,’ e.g., specialty chemicals from novel inputs (EBTP 2008: SRA-23).

Its precursor organization drew an analogy between plant material and crude oil: ‘New developments are ongoing for transforming the biomass into a liquid ‘biocrude’, which can be further refined, used for energy production or sent to a gasifier’ (Biofrac 2006: 21). The biocrude metaphor naturalizes the use and redesign of plants as functional substitutes for fossil fuels, and thus for horizontally integrating agriculture with other industries. Here an economic imaginary presents new technologies as market imperatives and opportunities, while a socio-technical imaginary presents markets as drivers of technoscientific progress. The neoliberal emphasis on markets frames the sustainability problem as a technical issue of accessing and optimizing renewable resources, i.e. decomposable biomass. For example, the prospect of (second generation) lignocellulosic fuels illustrates how market opportunities frame technical problems. Lignin in plant cell walls impedes their breakdown, thus limiting the use of the whole plant as biomass for various uses including energy. For agricultural, paper and biofuel feedstock systems, ‘lignin is considered to be an undesirable polymer’ (EPOBIO 2006: 27) – and so must be redesigned.

Shaping and funding R&D agendas

These imaginaries inform R&D agendas, especially via industry lobbies which favour biomass-to-liquid (BTL) fuel technology for several reasons. BTL offers links with other industries and export markets, as well as a potential basis for multiplying value chains. It also complements the existing transport infrastructure that is locked into liquid fuel technologies. According to the European Biofuels Technology Platform:

Liquid fuels are the preferred choice for road transport due to their relatively higher energy density and the fact that their use, particularly as blends, is more compatible with existing fuel distribution systems and requires little or no modification to power trains. (EBTP 2008: SRA-1)

Substantial funds have therefore been allocated to R&D agendas focused on novel biofuels under the EU's Framework Programme 7, in both the Energy and Agriculture programmes. Informed by industry's priorities, the EU funded a joint call for proposals on 'Sustainable Biorefineries', initially offering €80m total grants. The overall programme has several aims which include: 'enhancing energy efficiency, including by rationalizing use and storage of energy; addressing the pressing challenges of security of supply and climate change, whilst increasing the competitiveness of Europe's industries' (DG Research/Energy 2006: 4). For the latter aim, second-generation biofuels are expected to 'boost innovation and maintain Europe's competitive position in the renewable energy sector' (CEC 2007a: 11). In these ways, renewable energy is framed as more efficiently linking agriculture with energy for proprietary knowledge in global value chains.

As grounds for greater R&D expenditure, industry has emphasized the closed-loop concept, in that wastes must be continually turned into raw materials for the next stage: 'It will be necessary to optimize closed-loop cycles and biorefinery concepts for the use of wastes and residues in order to develop advanced biomass conversion technology' (EBTP 2010: 7, 16). These novel value chains would depend on significant changes in inputs, processing methods, and outputs.

A successful biorefinery would eventually depend on government subsidies for R&D&D – research and development and demonstration plants. According to speakers at the 2010 stakeholder meeting of the Biofuels Technology Platform, the necessary investment is too costly and commercially risky for the private sector, which therefore requests much more public funds to cover the risks. Testing commercial viability requires an expensive scale-up: 'With an estimated budget of €8 billion over 10 years, 15 to 20 demonstration and/or reference plants could be funded' (EBTP 2010: 26). Indeed, without public funds, such research would not get done in the EU.

As labelled by neoliberalism, this 'market failure' provides an important rationale for state intervention supporting new markets. From a critical perspective, such a policy illustrates how neoliberal strategy socializes risks (e.g. R&D costs) and privatizes benefits (e.g. resulting products). Despite the neoliberal rhetoric of freeing market forces, the public sector has been historically decisive in investing in financially risky new technologies. The effect is to subsidize the industry, socialize the cost and privatize the benefits (Block and Keller 2011).

Along those lines, the Commission had already proposed such a large expenditure programme under the 'sustainable bio-energy Europe initiative', likewise favouring BTL conversion processes within diversified biorefineries (CEC 2009). The public sector faces a potentially enormous investment for a speculative promise – whose successful fulfilment would benefit specific private sectors, aided by indirect subsidy from EU targets and from national measures such as tax incentives. Future value chains depend upon the state funding technological scale-up, as well as creating market conditions to support this technoscientific innovation. Here again are overlapping economic and socio-technical imaginaries, together mobilizing public funds for private gain.

However, BTL has faced much criticism as unsustainable. Biomass conversion into combined heat and power offers greater efficiency and GHG savings than BTL, according to a German report (SRU 2007). Indeed, 'there are better ways to achieve greenhouse gas savings and security of supply enhancements than to produce biofuels. And ... there are better uses for biomass in many cases', according to an EC expert report (JRC 2008: 22).

Moreover, according to an NGO, the Commission funds research agendas favouring 'private interests', e.g. agbiotech, GM trees, biofuels and processing techniques for their products. And 'promotion of agrofuel production in Latin America for the European market is likely to lead to further expansion of monocultures, destroying natural habitat and replacing small-scale farming systems' (CEO 2009). This criticism indicates a tension between environmental versus economic sustainability, and thus between different imaginaries. Since 2007 this tension has been highlighted by greater disputes over changes in land use.

Disputing sustainability, imagining a techno-fix

By 2007 biofuel expansion was provoking worldwide controversy over various harmful effects, especially in the global South. Such effects include land grabs, deforestation, community dispossession, more chemical-intensive cultivation methods, etc. Many critics counterposed the term ‘agrofuel’, highlighting the threat it poses ‘because of the intensive, industrial way it is produced, generally as monocultures, often covering thousands of hectares, most often in the global South’. In response to US and EU targets, moreover, ‘the rapid development of agrofuel markets is encouraging investment in farming operations by the agrofuel industry, already prospecting developing countries for suitable land for energy crops’ (Econexus et al. 2007: 6, 22). For several years, Greens in the European Parliament had been promoting biofuels, but now they more clearly sought to exclude food crops and restrict the biomass source to waste materials that would otherwise have no use (Lipietz 2008).

To undermine the EU’s proposal for mandatory targets, critics emphasized the ‘carbon debt’ that results from directly ploughing up forests or grasslands for newly cultivated land. This generates enormous GHG emissions, equivalent to decades of substituting biofuels for fossil fuels. Beyond direct changes in land use, indirect changes can result from crop substitution across the globe. For example, as the EU’s leading biofuel user, Germany draws on domestic or Eastern European sources of oilseed rape; its former food uses generate extra imports of palm oil from more distant sources, especially from Indonesia, where new plantations destroy forests.

In such ways, biofuel production displaces food crops to other places, where a once-off destruction of forest or peatland releases enormous GHG; this ‘carbon debt’ undermines the GHG savings from biofuels (Fargione et al. 2008, Searchinger 2008). Controversy ensued over the extent of such effects, called ‘indirect land-use changes’ (ILUC). Land-use change became NGO arguments against the Commission’s proposal for a 10% biofuels target by 2020, to be formalized in a new Directive (see next section).

However, these criticisms were turned into an extra argument for pursuing a techno-fix: that is, high targets were necessary to stimulate biofuel innovation that would minimize environmental destruction. According to a research network funded by the European Commission:

At a time when the expansion of first-generation biofuels derived from food crops is causing concern and in some sectors of the public active opposition related to questions of sustainability and competition with food, more emphasis has to be placed on second-generation biofuels (Coombs 2007: 17).

Future novel biofuels are variously described as ‘second-generation,’ ‘next-generation,’ ‘advanced,’ etc. They would use non-food parts of plants, or non-food plants such as grasses, or even algae, as means to avoid extra pressure on fertile arable land. As an extra basis for eco-efficiency, such innovations are expected to use ‘marginal land’ for growing novel non-food crops and to turn ‘bio-waste’ into energy. Such resources are seen as ‘under-utilized’ or ‘under-valued’, i.e. resources otherwise contributing little to markets.

‘Marginal land’ would allow novel biofuels to avoid the damage caused by current ones, according to the Trade Commissioner who was also promoting global trade liberalization:

We have all seen the maps showing the vast tracts of land that would be required to replace petrol to any significant degree. That is why research and development into second generation biofuels that are cleaner, more versatile, and can be used on more marginal land is so important. (Mandelson 2007)

The European Commission’s unit which assists developing countries foresees a similar remedy: ‘The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain’, as a means to avoid competition for land use (EuropeAid 2009). Numerous policy documents imagine that ‘marginal land’ is abundantly available for biofuel crops, i.e. that this novel use would make cultivation economically viable but without undermining other land uses (Franco et al. 2010).

Such arguments have provided a rationale for EU biofuel targets – as essential incentives for investment in technological development bringing next-generation biofuels, in turn solving the problems created by the first generation. These expectations for a techno-fix assume or imply that

inefficient resource usage causes the sustainability problems of current biofuels. With sufficient market incentives, furthermore, the techno-fix is meant to resolve these issues.

Mandating biofuels targets, stimulating innovation, accounting for carbon

When the global biofuel controversy erupted in 2007, the EU already had voluntary targets for ‘biofuels or other renewable fuels for transport’ and was discussing proposals to make them mandatory. At its March 2007 meeting the EU Council reiterated support for mandatory targets – subject to biofuel production being sustainable and second-generation biofuels becoming commercially available. The Commission’s legislative proposal eventually emphasized ‘renewable energy’ for transport fuel, thus downplaying biofuels (CEC 2008). As a basis for formalizing and legitimizing mandatory EU targets, warnings about unsustainable biofuels were translated into debates over sustainability criteria. Environmental issues were reduced to ‘carbon stock’ levels and GHG emissions which could be readily calculated, at least for direct changes in land use; other environmental issues were marginalized.

In the debate over sustainability criteria for 2020 targets, each stakeholder group sought to shape or limit a biofuel market in different ways. The biofuels industry supported high targets with stringent criteria for GHG savings, especially as means to stimulate R&D for future novel biofuels and to guarantee a market for them. Agriculture Ministries generally supported the high targets, especially as an extra support for farmers – but not the stringent criteria for GHG savings, which would exclude most biofuels then being produced in Europe. Environmental NGOs called for lower targets, thus seeking to minimize imports from the global South, as well as stringent criteria to protect environments and livelihoods there.

All the above arguments and pressures converged in a political compromise, the 2009 Renewable Energy Directive (RED), whose mandatory targets aimed to stimulate investment. The preamble emphasized ‘opportunities for establishing economic growth through innovation and a sustainable competitive energy policy’; in particular, ‘mandatory targets should provide the business community with the long-term stability it needs to make rational, sustainable investments in the renewable energy sector’ (EC 2009: 16, 17).

Towards the policy aims, 20% of all energy must come from renewable sources (including biomass, bioliquids and biogas) by the year 2020. Likewise, 10% of total transport fuel must come from renewable energy. Sustainability criteria define which biofuels qualify for the targets: greenhouse gas savings must rise from 35% to 50% in 2016 for existing production and to 60% for new installations in 2017. At the time the RED was enacted, the future 60% criterion was fulfilled only by Brazilian bioethanol.

The RED incorporates wider assumptions about resource conflicts resulting from inefficiency, to be remedied through market-like incentives. GHG savings are double-counted for several categories: co-products which could be used for other energy sources or animal feed; wastes and residues, assuming that they have no other use; and advanced biofuels from non-edible material, assuming that the GHG emissions can be assigned to the edible parts. Together those bonuses were meant to reward and stimulate novel biofuels using non-edible plant material, wastes, etc. and/or generating more co-products. The latter are presumed to reduce pressures on land, as if the market were finite: ‘Co-products normally replace animal feed, freeing up land that would otherwise be needed for its production’ (CEC 2010: 13). In this imaginary, statutory incentives will stimulate new markets that drive technoscientific innovation towards reducing pressures on natural resources.

Industry expectations for market incentives have led to some disappointment. As it turns out, the bonus in GHG savings favours cheap waste materials as feedstock and advanced biofuels whose production cost is similar to first-generation biofuels. This advantage deters investment in more expensive advanced biofuels, especially those needing novel enzymes. So the RED criteria create a ‘market distortion’, complains a biofuel representative (Vierhout 2011). Paradoxically, state rules are blamed for creating the wrong type of market and thus distorting a market – which would otherwise not exist. As this complaint reveals, official environmental aims help to justify the fundamental, less explicit aim of subsidizing and creating new markets.

The RED specifies adverse changes in land use which would preclude ‘sustainable biofuels’. Producers should avoid ‘the conversion of high-carbon-stock land that would prove to be ineligible for producing raw materials for biofuels and bioliquids’ (EC 2009: 24). Environmental criteria disqualified any biomass sources from ‘highly biodiverse’, ‘primary forest’ and ‘continuously forested’ areas; the latter were defined by statistical criteria. Compliance will be assessed on the basis of company

information, or through voluntary certification schemes or bilateral and multilateral agreements (EC 2009).

Indirect land use change (ILUC) has remained controversial. Some environmental NGOs and Green MEPs proposed to include an extra calculation within the sustainability criteria. Instead the issue was deferred: under the RED, by December 2010 the Commission must report on ways to calculate ILUC and to minimize its impact (EC 2009, see end of this section for outcome in CEC 2010).

Also at issue was social sustainability. A Parliamentary committee had proposed that sustainability criteria should include social aspects, e.g. land rights of local communities and fair remuneration of workers. But these criteria were ultimately excluded, partly on grounds that they would contravene WTO rules on trade barriers (EP Envi 2008, Biofuelwatch et al. 2008). 'These directives do not include mandatory social criteria (labour conditions, land tenure, etc.), nor food security criteria, because of the difficulty to verify the link between individual biofuel consignments and the respect of these particular criteria', according to a Commission development agency (EuropeAid 2009: 2). Indeed, complex trade flows leave no one responsible for harmful consequences.

Novel future biofuels were meant contribute significantly to the 10% target, yet these expectations were soon contradicted by the aggregate National Renewable Energy Action Plans (NREAPs). Their implications were analysed in a NGOs' joint report which was ominously entitled, *Driving to Destruction*. According to its analysis, conventional biofuels would contribute up to 92% of total predicted biofuel use, representing 8.8% of the total energy in transport by 2020. Moreover, '72% of this demand is anticipated to be met through the use of biodiesel and 28% from bioethanol' (Bowyer 2010: 2) – significant because biodiesel causes relatively greater harm than bioethanol via ILUC effects.

On that basis, the NGOs' report questioned the 10% target. They warned that emissions from ILUC will be '80.5 to 166.5% worse than would be delivered from continued reliance on fossil fuels in the transport sector', especially as the EU uses more biodiesel. 'Moreover, it also raises urgent questions about the appropriateness of projected levels of conventional biofuel use by Member States in 2020' (Bowyer 2010: 2). Several NGOs warned that many decades or even centuries may be needed to repay the 'carbon debt'. Meanwhile this debt is concealed by 'carbon laundering' through statutory criteria which account only for direct changes in land use (Birdlife International 2010).

In response to the ILUC controversy, the Commission held a public consultation (DG Energy 2010). NGOs argued that ILUC effects warrant more stringent sustainability criteria, in order to justify the 10% target as environmentally beneficial. Industry argued that available ILUC models suffer from methodological weaknesses, thus providing no basis for extra regulatory measures. And industry warned that such measures would jeopardize biofuel investment (ILUC 2010).

Afterwards the Commission left open its future policy options. Its report reiterated the EU's beneficent expectations for future technological innovation, which depends on incentives for private-sector investment:

Biofuels are important because they help tackle two of the most fundamental challenges in energy policy with regards to transport: the overwhelming dependency of the transport sector for oil and the need to decarbonise transport. Supporting biofuels offers other opportunities too. They can contribute to employment in rural areas, both in the EU and in developing countries and they offer scope for technological development, for example in second-generation biofuels. [...] In this context the stable and predictable investment climate created by the Renewable Energy Directive [...] needs to be preserved. (CEC 2010: 2, 14)

In this circular reasoning, echoing industry stances, EU policy must maintain profit-seeking incentives to generate future innovation alleviating the harm caused by current markets. Industry expectations to profit from future innovation, combining socio-technical and economic imaginaries, supersede governments' acknowledgement that advanced biofuels will make little contribution by 2020.

Conclusion: Neoliberalizing technoscience and environment

Let us return to the original focus — how EU biofuels policy:

- stimulates new markets for knowledge as well as resources;
- conceptualizes and designs markets as a driver of beneficent innovation; and thus
- deepens links between technoscience and neoliberalism.

EU biofuels policy promotes a vision of a feasible, desirable future Europe constituted by economic and socio-technical imaginaries. Namely, market-driven innovation will generate ‘competitive, sustainable biofuels’ within a wider Knowledge-Based Bio-Economy (KBBE). This will achieve a benign eco-efficient productivity using resources which are renewable, reproducible and therefore sustainable: such resources (especially non-food biomass) will replace fossil fuels. Future biofuel production will efficiently use renewable resources to enhance energy security, economic competitiveness, technology export and GHG savings – aims which already drive innovation, according to the imaginary.

As a key imperative for biofuels, EU policy foresees greater future demand for oil imports and thus energy insecurity, as if this were an objective external force. In practice, such pressures result from long-standing market-based policies (e.g. transport infrastructure, internal market, trade liberalization, etc.) throwing people and products into greater competition with each other. In this neoliberal context, EU biofuels policy naturalizes energy insecurity, which is attributed to external pressures such as oil dependence. Likewise greater pressures on land and natural resources are naturalized; they are attributed to global market demand, as if this were external to the production system for food, feed and energy. Within those problem-definitions, biofuels are promoted as a multi-purpose remedy, which can be characterized as a technological fix: future efficiency improvements will sustainably expand biofuel production, while minimizing demands on natural resources. This agenda promotes new markets for natural resources, while discursively naturalizing those markets as rooted in biological characteristics and objective imperatives.

That relationship between neoliberalism and technoscience seems to shape the EU policy framework. To construct new markets for biofuels, EU policy has two complementary means: biofuel targets and R&D subsidy, which can be summarized as follows. As a statutory target, 10% of transport fuels must come from renewable energy by 2020 under the 2009 RED. The target mandates a significant market which otherwise would hardly exist, in the name of environmental benefits. These markets are regulated by sustainability criteria, incorporating only those issues which can be calculably reduced to carbon accounting. Through profit-seeking incentives and standards, the RED aims to stimulate investment and innovation to fulfil the target, eventually through more sustainable biofuels to comply with stricter standards for installations built after 2017. In practice, the draft RED was already stimulating land grabs anticipating opportunities to supply new EU markets.

In parallel, industry promotes research agendas for horizontally integrating agriculture with other industries, including energy production, especially through an integrated biorefinery. Its agenda favours biomass-to-liquid technologies, which offer various prospects for privatizing knowledge, as a central feature of the broader Knowledge-Based Economy agenda (cf. Jessop 2005). R&D agendas redesign nature for real subsumption to capital accumulation (cf. Boyd, Prudham and Schurman 2001), e.g. by changing cell-wall composition for easier breakdown or entire plants for high-value substances. At the same time, industry requests enormous subsidy on grounds that the financial risks of early-stage development are too great for private investors. The EU’s Framework Programme 7 has incorporated these neoliberal imaginaries into research priorities, e.g. for ‘sustainable biorefineries’.

As an economic imaginary around biorefineries, ‘value chains’ help to mobilize political, financial and organizational investment for biofuels R&D. New cross-sectoral industry coalitions imagine an economic community gaining together from future technological development. Given various competing interests, intra-EU rivalry for global capital integration is represented as ‘European competitiveness’, as if Europe were a unitary interest (cf. Rosamond 2002).

R&D anticipates a diversified biorefinery integrating agriculture with other industrial sectors. Investors seek an advantageous position in future global value chains from agriculture, seen as new ‘oil wells’ whose biomass can be ‘cracked’ and recomposed into more valuable components. Future biofuels are also promoted as an opportunity for European technology export, e.g. agri-inputs and

biomass processing techniques which can be patented. In these ways, the 'value chains' concept combines economic imaginaries with socio-technical imaginaries to stimulate new investments.

These imaginaries extend a cornucopian vision of resources for lucrative biomass, especially via its redesign, diversification and recomposition for multiple uses. Vast areas are imagined as 'marginal land', unnecessary for food production and so benignly available for agro-industrial systems. This concept helps to justify EU targets which stimulate changes in land use, despite causing environmental destruction and dispossessing local populations. These changes exemplify capital accumulation by dispossession (Harvey 2003), whereby investors gain access to cheap human and natural resources at new commodity frontiers (Moore 2010).

EU targets have remained contentious, for several reasons. The market drivers of harm have been highlighted by many NGO critics, thus politicizing EU targets. These stimulate harmful land-use changes, especially in the global South. Despite expectations and incentives for novel biofuels, nearly the entire 10% target by the year 2020 will come from conventional biofuels, thus stimulating direct and indirect changes in land use. These create an enormous 'carbon debt', which plausibly undermines GHG savings and renders most biofuels 'unsustainable', thus contradicting the official environmental rationale. Indirect land-use change (ILUC) has been deferred from any statutory rules, which fall within the standard disciplines of trade liberalization, thus imposing a great burden of evidence to justify any extra 'discriminatory' criteria.

Meanwhile the EU biofuel controversy has been channelled into disputes over carbon accounting and its methodological difficulties in predicting environmental effects. Those difficulties are turned into policy deference to neoliberal imperatives, especially an 'investment climate' for market competition, as the implicit knowledge-base for technological solutions (cf. Lave, Mirowski and Randalls 2010), thus depoliticizing EU targets. In such ways, environmentalism has been incorporated into models of market progress, as a more effective neoliberal strategy than simply disregarding environmental issues (cf. McCarthy and Prudham 2004).

In all those ways, EU biofuel policy illustrates the joint neoliberalization of technoscience and the environment. Through circular reasoning, incentives for profit-seeking investment must be maintained in order eventually to achieve the 10% target, in innovative ways avoiding the harm caused by current biofuels. Such incentives are meant to generate 'competitive, sustainable biofuels' – by stimulating technoscience, regulating its forms or direction, distributing its societal benefits and optimizing resource usage. In practice, EU targets stimulate capital accumulation by socio-economic dispossession and more GHG emissions; more 'efficient' innovations may provide even greater incentives. Official environmental aims help to justify the less explicit aim of subsidizing and creating new markets.

This agenda is depoliticized as a benign, omniscient market – justified and guided by sustainability criteria – as the most efficient mechanism to achieve environmental goals. Any political accountability is reduced to carbon accounting, in turn relegated to specialists, while marginalizing other knowledges. Thus the EU policy framework facilitates plunder and commoditization of natural resources – in the name of conserving them, perhaps like neoliberalization processes in general.

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Neoliberalism and Technoscience: Critical Assessments

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This book provides a comprehensive assessment of the connection between processes of neoliberalization and the advancement and transformation of technoscience. Drawing on a range of theoretical insights, it explores a variety of issues including the digital revolution and the rise of immaterial culture, the rationale of psychiatric reforms and biotechnology regulation, discourses of social threats and human enhancement, and carbon markets and green energy policies.

A rich exploration of the overall logic of technoscientific innovation within late capitalism, and the emergence of a novel view of human agency with regard to the social and natural world, this volume reveals the interdependence of technoscience and the neoliberalization of society. Presenting the latest research from a leading team of scholars, Neoliberalism and Technoscience will be of interest to scholars of sociology, politics, geography and science and technology studies.

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Reviews:

'Readers will come away from this book with the distinct sense that "neoliberalism", whatever its strengths and weaknesses, has successfully forced humanity to re-define itself as a species in the face of various technoscientific promises and products that so-called neoliberals have promoted.'

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'Referring to Escher's famous work of Drawing Hands, the authors take-up the challenge of sketching the co-construction of neoliberalism and technoscience. By providing enlightening analyses and original perspectives the book moves this complicated relationship to the foreground of academic debate, inspiring us to rethink connections and explore them further.'

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